CLAIMS:

1. A method comprising:

generating a stream of frames from blocks of information bearing symbols, wherein the frames corresponding to different blocks of the symbols are interleaved;

generating a stream of chips from the stream of frames, wherein the chips corresponding to different frames are interleaved; and

outputting an ultra wideband (UWB) transmission signal from the stream of chips.

2. The method of claim 1, wherein generating a stream of frames comprises:

parsing the symbols into blocks of K symbols;

applying an orthogonal set of spreading codes to the blocks of K symbols to form Q frames; and

interleaving the Q frames to form the stream of frames.

3. The method of claim 2, wherein applying an orthogonal set of spreading codes comprises applying direct sequence code-division multiple access codes or digital carrier frequency division multiple access codes.

4. The method of claim 2, wherein generating a stream of chips comprises:

applying an orthogonal set of time-hopping spreading codes to the interleaved frames to generate a plurality of chips for each frame; and

interleaving each of the plurality of chips to form the output stream of chips.

5. The method of claim 4, wherein generating a stream of chips further comprises:

storing the chips in an array having M columns and K+L rows, where L is a function of the communication channel length; and

padding each column of the array with L guard chips.

6. The method of claim 5, wherein the guard chips comprise null values.

7. The method of claim 5, wherein outputting the transmission signal by reading the chips from the array in column-wise fashion.

8. The method of claim 5, wherein the set of spreading codes and the set of time-hopping spreading codes are mutually orthogonal so that the interleaved and padded chips retain their orthogonality after passing through a multi-path communication channel.

9. The method of claim 5, further comprising:

assigning each of the set of spreading codes to a different user of a group of users; and

assigning each user of the group a common one of the set of time-hopping spreading codes.

10. The method of claim 5, further comprising assigning unique addresses to users as unique pair-wise combinations of the set of orthogonal spreading codes and the set of time hopping spreading codes.

11. The method of claim 10, wherein the total number of users N_u supported by the wireless communication devices equals $N_c * N_f$, where each of the information bearing symbols is repeated over N_f frames and each frame includes N_c chips.

12 The method of claim 11, wherein each of the unique addresses comprises a unique multiple user address (u_B) selected from set of spreading codes in combination with a unique time-hopping address (u_A) selected from the set of time-hopping codes.

13. The method of claim 12, further comprising selecting the unique multiple addresses and the unique time-hopping addresses in accordance with:

$$u_A = u \pmod{N_C}, \text{ and}$$

$$u_B = \lfloor u / N_c \rfloor.$$

14. The method of claim 1, further comprising:

receiving the signal; and

outputting a stream of estimate symbols from the signal using a two-stage de-spreading unit having a time-hopping de-spreading module and a multi-user de-spreading module.

15. The method of claim 14, wherein outputting a stream of estimate symbols comprise:

converting the signal to a stream of chips;

applying a first de-spreading matrix with the time-hopping de-spreading module to de-interleave the chips into blocks of frames;

applying a second de-spreading matrix to the blocks of frames with the multi-user de-spreading module to de-interleave the frames and produce blocks of estimate symbols; and

applying a single user detection scheme to the blocks of estimate symbols to output the stream of the estimate symbols.

16. The method of claim 15, wherein applying first and second de-spreading matrices deterministically eliminates multiple user interference.

17. The method of claim 15, wherein applying a first de-spreading matrix comprises:

parsing the chips into blocks of P chips; and

applying a time-hopping de-spreading matrix of size $P \times N_f(K+L)$ to the blocks, where each of the information bearing symbols is repeated over N_f frames, L is a function of the communication channel length, and the stream of frames was generated during transmission using blocks of K symbols.

18. The method of claim 15, wherein applying a second de-spreading matrix comprises applying a second de-spreading matrix of size $N_f(K + L) \times (K + L)$ matrix, where each of the information bearing symbols is repeated over N_f frames, L is a function of the communication channel length, and the stream of frames was generated during transmission using blocks of K symbols.

19. A wireless communication device comprising:

a multiple-user block-spreading unit that generates a set of frames for respective blocks of information bearing symbols and produces a stream of frames in which the frames from different sets are interleaved;

a time-hopping block-spreading unit that generates a set of chips for each frame and outputs a stream of chips in which the chips generated from different frames are interleaved; and

a pulse shaping unit to output an ultra wideband (UWB) transmission signal from the stream of interleaved chips.

20. The wireless communication device of claim 19, wherein the multiple-user block-spreading unit produces the stream of frames by parsing the symbols into blocks of K symbols, applying an orthogonal set of spreading codes to the blocks of K symbols to form Q frames and interleaving the Q frames to produce the stream of frames.

21. The wireless communication device of claim 20, wherein the set of spreading codes comprises direct sequence code-division multiple access codes.

22. The wireless communication device of claim 20, wherein the time-hopping block-spreading unit generates the stream of chips by applying an orthogonal set of time-hopping spreading codes to the interleaved frames to generate a plurality of the chips for each frame, and interleaving each of the plurality of chips to form the output stream of chips.

23. The wireless communication device of claim 22,

wherein the time-hopping block spreading unit comprises memory to store the chips in an array having columns and rows, where the number of rows in the array is a function of the communication channel length, and

wherein the time-hopping block spreading unit pads each column of the array with guard chips, and outputs the transmission signal by reading the chips from the array in column-wise fashion.

24. The wireless communication device of claim 22, wherein the set of spreading codes and the set of time-hopping spreading codes are mutually orthogonal so that the interleaved and padded chips retain their orthogonality after passing through a multi-path communication channel.

25. The wireless communication device of claim 24, wherein the wireless communication device stores a unique address assigned to one of a plurality of users, and the unique address is formed from a pair-wise combination of one of the set of orthogonal spreading codes and one of the set of time hopping spreading codes.

26. The wireless communication device of claim 19, wherein the wireless communication device comprises one of a base station and a mobile device, a device within a personal area network, or a device within a sensor network.

27. A wireless communication device comprising a two-stage despreading unit that processes a received ultra wideband (UWB) transmission signal to produce estimate symbols, wherein the received UWB signal comprises a multi-user block-spread UWB signal formed from interleaved symbol frames and interleaved chips within the symbol frames.

28. The wireless communication device of claim 27, wherein the two-stage de-spreading unit comprise:

a time-hopping de-spreading module that applies a first de-spreading matrix to de-interleave the chips into blocks of frames, and

a multi-user de-spreading module that applies a second de-spreading matrix to de-interleave the frames and produce blocks of the estimate symbols.

29. The wireless communication device of claim 28, wherein the wireless communication device comprises one of a base station and a mobile device.

30. A system comprising:

a wireless transmitter to transmit an ultra wideband (UWB) signal according to interleaved chips generated from interleaved frames produced by blocks of information bearing symbols; and

a wireless receiver to receive the UWB signal and de-interleave the chips and frames to produce estimate symbols.

31. The system of claim 30, wherein the transmitter comprises:

a multiple-user block-spreading unit that generates a set of the frames for the respective blocks of information bearing symbols and produces a stream of the frames in which the frames from different sets are interleaved;

a time-hopping block-spreading unit that generates a set of the chips for each of the frames and outputs a stream of the chips in which the chips generated from different frames are interleaved; and

a pulse shaping unit to output the UWB transmission signal from the stream of interleaved chips.

32. The system of claim 30, wherein the receiver comprises:

a time-hopping de-spreading module that applies a first de-spreading matrix to the UWB signal to de-interleave chips into blocks of frames, and

a multi-user de-spreading module that applies a second de-spreading matrix to de-interleave the frames and produce blocks of the estimate symbols.

33. A computer-readable medium comprising instructions to cause a programmable processor of a wireless communication device to:

generate a stream of frames from blocks of information bearing symbols, wherein the frames corresponding to different blocks of the symbols are interleaved;

generate a stream of chips from the stream of frames, wherein the chips corresponding to different frames are interleaved; and

output an ultra wideband (UWB) transmission signal from the stream of chips.